

**2001 IEEE Antennas and Propagation  
Society International Symposium and  
USNC/URSI National Radio Science Meeting**

*Sheraton Boston Hotel  
Boston Massachusetts  
July 8-13, 2001*

**100 Years of Communications: 1901-2001  
Transatlantic to Geosynchronous**

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## CHAIRMAN'S WELCOME

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Welcome to Boston, where it all began ...

On behalf of the steering committee I would like to welcome all of you to Boston for the 2001 IEEE International Antennas and Propagation Symposium and USNC/URSI National Radio Science Meeting. The meeting will be held during the week of July 8-13, 2001. We have prepared a full technical program with several special sessions, a variety of short courses and workshops, and a comprehensive array of exhibitors.

The conference will be held at the newly remodeled Sheraton Boston Hotel, located in downtown Boston, convenient to numerous attractions such as Old Ironsides (the oldest commissioned warship in the world); Boston Common and Public Garden, with its Make Way For Ducklings statues; Fenway Park, home of the ever-interesting Red Sox; The Prudential Mall Complex; and world-famous Symphony Hall. The hotel is located 5 miles from Logan International Airport.

Boston is an exciting city, and we have drawn on its many resources to put together an appealing social program with activities for all ages, individuals, families, groups, and tastes. In addition to the Sunday evening Social and the traditional Wednesday Awards Banquet, we have planned Monday evening at the Boston Museum of Fine Arts and a Tuesday evening Boston Harbor Cruise, with a lobster dinner. We are offering daytime bus tours to historic Lexington and Concord, birthplace of our nation; to Salem Mass, for a visit to the House of Seven Gables, the Salem Witch Museum, and historic Pickering Wharf; and a picnic cruise to George's Island, one of the secret treasures of Boston Harbor. We also provide information on several of the many 'do-it-yourself' tours available, such as the Duck Tour, where you cruise the streets and waterways of Boston in an authentic World War II amphibious vehicle.

I hope your plans for July 2001 include attending the APS/URSI Conference. We have an excellent experience planned for you!

Robert V. McGahan, General Chair  
Sensors Directorate  
Air Force Research Laboratory  
Hanscom Air Force Base, Massachusetts 01731-2909

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## STEERING COMMITTEE

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**General Chairman**

Robert V. McGahan

**Vice Chairman / Student****Competition**

Robert J. Mailloux

**Local Arrangements**

Michael Fiddy

**Short Courses**

Hans Steyskal

**Technical Program**

Ronald Fante

Allen Fenn

**Special Sessions**

Keith Trott

**Vice Chairman**

Jeffrey Herd

**Digest/Publications**

Robert V. McGahan

Douglas Drew

Kathleen Ballos

**Exhibits**

Jonathan Williams

**Finance Committee**

Livio Poles

**Database**

Kathleen Ballos

**URSI Liaison**

B. Rama Rao

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## APS AND URSI REVIEWERS

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Robert Adams

Edward Altshuler

Robert Atkins

Herb Aumann

S. Balasubramanian

Frank Barnes

Gary Brown

Blair Carlson

Richard Davis

Sean Duffy

S. ElGhazaly

Ronald Fante, Chair

Alan Fenn, Co-Chair

John Foster

Om Gandhi

Mark Gouker

Susan Hagness

Hsui Han

Jeff Herd

Lisa Hubbard

David Jones

Peter Kao

Kris Kim

David Lamensdorf

Min-Chang Lee

Robert McGahan

Robert Mailloux

Krys Michalski

A. Michelson

David Mooradd

Robert Nevels

Eugene Ngai

David Pozar

B. Rama Rao

Carey Rappaport

Dan Schaubert

Jay Schindler

J. Schoenberg

Mike Shields

Gary Somers

Hugh Southall

Hans Steyskal

Ross Stone

Steve Targonski

Lucien Teig

Keith Trott

P. L. Uslenghi

E. Westwater

Frank Willwerth

Jonathan Williams

Amir Zaghloul

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## AWARDS

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### IEEE 2001 Awards

#### **2001 IEEE Electromagnetics Award**

Fawwaz Ulaby

### Antennas and Propagation Society 2001 Awards

#### **2001 Distinguished Achievement Award**

Peter Clarricoats

#### **2001 Chen-To Tai Distinguished Educator Award**

Professor Emeritus Ronold W. P. King

#### **2001 S. A. Schelkunoff Transactions Prize Paper Award**

Jun-Sheng Zhao and Weng Cho Chew  
*for their paper "Integral Equation Solution of Maxwell's  
Equations from Zero Frequency to Microwave  
Frequencies," October 2000*

#### **Honorable Mention for the Schelkunoff Award**

Akira Ishimaru, John D. Rockaway, Yasuo Koga, and  
Seong-Woo Lee  
*for their paper "Sommerfeld and Zenneck Wave Propagation for  
a Finitely Conducting One-Dimensional Rough Surface,"  
September 2000*

#### **H. A. Wheeler Applications Prize Paper Award**

Christophe Granet, Trevor S. Bird, and Graeme L. James  
*for their paper "Compact Multimode Horn with Low Sidelobes  
for Global Earth Coverage," July 2000*

**Honorable Mention for the H. A. Wheeler Award**

Wei-Chun Chang, Gregory J. Wunsch,  
and Daniel H. Schaubert  
*for their paper "Back to Back Measurement for  
Characterization of Phased Array Antennas," July 2000*

**R. W. P. King Award**

Filippo Capolino  
*for the paper "Time Domain Green's Function for an Infinite  
Sequentially Excited Periodic Line Array of Dipoles," co-  
authored with Leopold Felsen, June 2000*

**Honorable Mention for the R. W. P. King Award**

Sean M. Duffy  
*for the paper "An Enhanced Bandwidth Design Technique for  
Electromagnetically  
Coupled Microstrip Antennas," February 2000*

**2001 AP-S/URSI B Awards**

**Raj Mittra Travel Grant Recipients**

Igor V. Ivanchenko , National Academy of Sciences of  
Ukraine

Ugur Oguz , Bilkent University, Turkey  
Yair Shifman , Technion - Israel Institute of Technology

**2001 IEEE Fellows**

Thomas Giles Campbell	Krzysztof A. Michalski
Lawrence Carin	Jaganmohan B.L. Rao
Daniel De Zutter	Roberto G. Rojas
Peter S. Hall	Robert Avery Shore
Ehud Heyman	Tadashi Takano

Jian-Ming Jin

Edgeworth R. Westwater

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## CONFERENCE FACILITATORS

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Conventures, Inc.  
One Design Center Place  
Boston, Massachusetts 02210

For information concerning reservations contact:

Nicole Huard  
617-439-7700

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## GENERAL INFORMATION

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### Registration

Registration is required of all symposium participants, including AP-S and URSI officials, session chairpersons, and authors. Registration may be completed by downloading a registration form at:

[www.ieeeaps.org/2001APSURSI](http://www.ieeeaps.org/2001APSURSI)

Participation in the short courses and social events requires payment of additional fees, as indicated on the registration form. Family members need not register for the symposium in order to participate in the social programs but must register and prepay for the events of interest. The full symposium registration fee includes admission to the pertinent technical sessions and a copy of the pertinent digests, admission to exhibits, breakfast, lunch and breaks Monday - Thursday.

Badges must be worn at all times to gain entry to the technical sessions, commercial exhibits, and social functions. Accompanying persons who complete the appropriate section of the registration form will be given a distinctive badge.

### Registration Desk

The conference registration desk will be located in the Republic Foyer. The desk will be staffed from 3:00-8:00 PM on Sunday, July 8<sup>th</sup>, and from 7:00 AM to 5:00 PM Monday – Thursday, July 9-12.

### Exhibitors

All exhibitor display will be in the Republic Ballroom adjacent to the registration area. Exhibitor booths will be open from 8:00 AM on Tuesday, July 10<sup>th</sup>, to 4:00 PM, Thursday, July 12<sup>th</sup>

### Breaks

Note that there are no scheduled intermissions for breaks. Refreshments will be available Monday-Thursday from 9:30-10:30 AM, and 2:30-3:30 PM. Refreshments will be located in the Beacon and Main Foyers on the third floor, and in the Republic Corridor next to the exhibits on the second floor.

### **Speaker Ready Room**

The Speaker Ready Room will be in Jefferson. An overhead projector and screen will be available for speakers to prepare for their presentations.

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## **HOTEL INFORMATION**

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The conference will be held at the newly renovated Sheraton Boston Hotel, 39 Dalton Street, Boston MA 02199. We have a block of rooms set aside at the conference rate of \$169.00 plus tax per night, but the number is limited and will be released after June 7, 2000. Reserve your rooms now. You can access the Sheraton Boston website either by going to the Symposium website at [www.ieeeaps.org/2001APSURSI](http://www.ieeeaps.org/2001APSURSI), going to the main Sheraton website at [www.sheraton.com](http://www.sheraton.com) and searching on Boston, Massachusetts, or going to the URL below:  
<http://www.sheraton.com/property.taf?prop=430&lc=en>

Make your reservations directly with Sheraton. To make reservations, call Sheraton's central reservation number 1-800-325-3535, or the Boston Sheraton number 1-617-236-2000. Be sure to specify that you are attending the **IEEE Antennas & Propagation Society/URSI Meeting**. You will be asked for the dates of the meeting.

### **SPECIAL NOTE FOR NON-U.S REGISTRANTS:**

There is a list of toll free numbers on the Sheraton website for most countries. These numbers will allow you to access the Sheraton World Wide reservation system, toll-free, from most countries. The URL is:

<http://www.sheraton.com/main.taf?lc=en&sec=des&sub=wro>

Note that Boston is a walking city. Parking is scarce and expensive. We strongly recommend that you do not rent a car for the entire week. There is ample and convenient public transportation both in the city and to and from the airport. The Sheraton is on Boston's subway's Green Line, a short walk from the Prudential Station.

There are a limited number of dormitory rooms available for bona fide full-time students. These rooms will be offered on a first-come, first-served basis. Proof of status will be required. If you qualify, and want one of these rooms call Margie Hobbs at 781-377-3200.

The Sheraton Boston is conveniently located close to The Shops at Prudential Center and the Copley Place Shops. Both are within easy walking distance, via covered walkways, and both have food courts for easy lunch and dinner access.

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## **TRAVEL INFORMATION**

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Carlson Wagonlit Travel is your designated travel consultant. You will find knowledgeable and friendly service to locate the best available fares on any airline. Contact Carlson Wagonlit at:

Telephone: (781) 821-0774

Toll Free (outside Massachusetts): (800) 878-8728

Fax: (781) 821-2642



When calling to make travel arrangements, specify that you are attending the 2001 APS/URSI Symposium in Boston and mention any special codes, if given.

### **Airlines**

Delta Airlines has been selected as the official Symposium air carrier. Delta offers the following discounts:

- a) Up to 10% discount off domestic published restricted fares
- b) Up to 15% discount off published Y06/YR06 fares (unrestricted).
- c) Zone fares, to be announced at a later date.

Call Carlson Wagonlit Travel between 9:00AM-5:00PM EST. They will help you with any airline or automobile reservations and will make sure you receive credit for frequent-flyer miles. You may call Delta direct at 1-800-241-6760. Mention Delta File Number 161054A for Domestic flights.

Special fares for international travel will be handled on a case-by-case basis.

### **Car Rental**

The following Avis rental car rates are available to Symposium attendees. To book direct, call 1-800-331-1600 and mention the Avis Worldwide Discount (AWD) number J099959. Carlson Wagonlit Travel can also help you get the same rate when you mention the AP-S Symposium and the AWD number.

CAR CLASS	Daily	Weekly	Weekend(per day)
SUBCOMPACT	\$48.99	\$143.99	\$30.99
COMPACT	\$50.99	\$165.99	\$31.99
INTERMEDIATE	\$53.99	\$187.99	\$33.99
FULL SIZE 4D	\$57.99	\$209.99	\$39.99
PREMIUM	\$62.99	\$242.99	\$53.99
LUXURY	\$69.99	\$282.99	\$69.99
MINIVAN	Same as Luxury		
SPORT UTILITY	Same as Luxury		

Rates apply July 8-13 2001. A 7 day window pre and post to the meeting applies (July 1-20) Weekend rates are available starting at 12:00noon Thursday and returning by 11:59pm on Monday All rates include unlimited free mileage All taxes, gas, insurance, surcharges, and other costs are additional Renters must meet Avis' age, driver, and credit requirements

### **Taxi**

Taxis fare from Logan Airport to Boston can range from \$12.00 - \$20.00, depending upon the time of day and traffic.

### **Airport Shuttle**

Shuttles run from Logan Airport to Boston hotels for approximately \$9.00 each way. In particular, City Transportation runs every half-hour, on the hour and half-hour, picking up at the baggage claim areas.

**Subway**

The Boston subway, known as the 'T,' stops at Logan Airport. You will take the Blue Line to Government Center and change to the Green Line (E Trolley) West-bound. The closest T stop to the Sheraton is Prudential.

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**REGIONAL INFORMATION**

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**Weather**

The weather in Boston can be extremely volatile. Although we often experience some of the best weather of the year in July the temperature can vary from 50 degrees F to over 100 degrees F. It can also be extremely humid, and rain is not unknown. The following historical data for July are offered for your information:

Average High: 82   Record High: 104

Average Low: 65   Record Low: 50

Average Precipitation: 2.68 inches

Average number of rain days: 9

The best advice we can give is bring a sweater and be prepared for anything except snow.

**Public Transportation**

Boston has an extensive public transportation system. The subway, referred to as the 'T,' comprises four color-coded lines that intersect at several stations in the downtown area. Transfers from one line to the other are free. There is also a sizable web of surface busses covering those areas that the T does not. A subway token costs \$1.00, good for a one-way ride anywhere on the system. In most instances free transfers are available from the subway to the busses, if your destination is not on one of the main lines.

**Highway System**

Boston lies on the East Coast of Massachusetts. Cape Cod and Rhode Island lie South and Southeast, while New Hampshire and Maine lie to the North and Northeast. Two circumferential highways ring Boston on the West. Route 128/I95 is the inner belt, while I495 is the outer belt. U.S Route 3 approaches from Cape Cod and the South Shore. I95 approaches from the South, via New York and Rhode Island. I95 continues to the Northeast and Maine, while Routes I93 and U.S 3 take one North into New Hampshire and Vermont. As stated elsewhere in this program, driving in Boston proper is not recommended. The streets are narrow, and hard to decipher, parking is limited and exorbitantly expensive, and construction caused by the Big Dig further compounds the problem.

**Tourist Information**

Greater Boston Convention & Visitors Bureau  
1-888-SEE BOSTON, fax: 617-424-7664  
Massachusetts Office of Travel & Tourism (617) 973-8500  
Toll-free: (800) 227-MASS (U.S. & Canada)  
Police 911  
Directory Assistance 411

**Hospitals**

Massachusetts General Hospital 617-726-2000  
Brigham & Woman's Hospital 1-800-294-9999  
Beth Israel Hospital 617-667-7000

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**THE SOCIAL PROGRAM**

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We have planned the following events for your enjoyment. The prices of the tours, as shown on the registration form, are based on a minimum number of attendees. Tours are subject to cancellation if there is insufficient interest. Please register early if you intend to participate. Spaces will be guaranteed only until May 1, 2001. After this date these tours will be offered on a space-available basis only.

**Welcome Social** – Sunday, July 8, 6:00-8:00 PM, Constitution Foyer

**Hospitality Room for accompanying persons** – Kent (M-Th)

**IEEE Women in Engineering (WIE) Reception** – Tuesday, July 10, 5:30 - 7:00 PM, Commonwealth

The Women in Engineering reception, sponsored by IEEE and IEEE AP-S, is open to all conference participants. There will be a brief presentation by an invited speaker on issues related to women in engineering, recruitment and retention. The reception will serve as a forum for the participants to discuss these issues and share their views and ideas regarding this subject. Refreshments will be served.

**Evening at the MFA** – Monday, July 9, 6:00-10:00 PM.

An evening visit to the Boston Museum of Fine Arts, with a catered buffet. The Museum of Fine Arts, also known as the MFA, contains one of the most important art collections in the country. The museum houses comprehensive art and sculpture galleries, superb Asian and Egyptian galleries, and rooms full of Impressionist works.

**Spirit of Boston** - Tuesday night, July 10, 6:00-10:00 PM.

An evening cruise on Boston Harbor aboard the cruise ship Spirit of Boston. View Boston's skyline from a truly unique vantage point. Watch the sunset while enjoying a lobster dinner.

**Dinner Honoring R.W.P. King** – Tuesday, July 10, 6:30-9:00 PM.

A special dinner in honor of Ronold King, who has served the electromagnetic community for over 60 years and educated over 100 PhDs. The dinner will be preceded at 1:00 PM by a special session of invited papers given in Professor King's honor. This dinner is open to all, not just Professor King's students. Cost of the dinner is \$45 per person. Interested parties should make reservations and send checks

before 22 June to: Edward Altshuler, 55 Montrose Street, Newton, MA 02458

**Awards Banquet and Reception** – Wednesday, July 11, 6:00-11:00 PM, Constitution Ballroom.

Please select your choice of entree from Medallions of Beef, Salmon Steak, or Stuffed Breast of Chicken, by circling the appropriate item on the registration form. After the banquet enjoy the rest of the evening listening and dancing to the New Black Eagle Jazz Band.

**George's Island** – Monday, July 9, 9:00 AM-2:00 PM.

Coach transfer to Boston Harbor to board the ferry for a 45 min. cruise to George's Island, one of Boston Harbor's picturesque islands. Once there, take a guided tour of the old Fort which stood guard over Boston Harbor. Then enjoy a picnic box lunch (provided) on the island before returning to the city.

**Salem/Marblehead** – Tuesday, July 10, 8:00 AM-3:00 PM.

Marblehead and Salem, "Maritime and Witches" Experience the uniqueness of Marblehead, a picturesque New England town and racing yacht capital of the world. Get breathtaking views of the Atlantic Ocean and the rocky coastline at Castle Rock on Marblehead Neck. Wind through Old Town to Salem and explore the haunted happenings at the Salem Witch Museum, a sight and sound presentation depicting the witch trials of 1692. Time for lunch and shopping at Pickering Wharf on Salem's historic waterfront before touring the House of the Seven Gables, the home that was the inspiration for Nathaniel Hawthorne's classic tale.

**Lexington/Concord** – Wednesday, July 11, 9:00 AM-1:00 PM

Lexington and Concord, "The Battle Trail" Follow the "Battle Trail" to Lexington, site of the first battle of the Revolutionary War. Stand on the Lexington Green and relive the battle of April 19th, 1775. In Concord, visit the North Bridge and listen to the historic echo of "...the shot heard 'round the world." Experience literary Concord while viewing the homes of Ralph Waldo Emerson, Nathaniel Hawthorne, Henry David Thoreau's Walden Pond, and tour The Orchard House, Louisa May Alcott's home.

**Tour of The World Famous Ipswich Antenna Range** –

Thursday, July 12, 9:00 AM-2:00 PM.

Ipswich MA: A tour of the Air Force Research Laboratory antenna measurements range in Ipswich MA is planned. This range was originally part of the MIT Radiation Laboratory complex during World War II. Many of the Rad Lab's crucial antenna measurements were made here. Busses will leave Boston in the morning for the 40 minute drive to Ipswich, on Boston's North Shore. After a tour of the range facilities a picnic lunch is planned on the grounds overlooking scenic Plum Island and Crane's Beach.

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## BUSINESS MEETINGS AND RECEPTIONS

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### ***Saturday, July 7***

Noon-5:00 pm Meetings Committee Subcommittees

*Jefferson*

6:30-10:00 pm

Meetings Committee & Dinner

*Jefferson*

### ***Sunday, July 8***

8:00-11:30 am

APS Past Presidents Meeting

*Jefferson*

Noon-5:00 pm

APS AdCom Meeting

*Commonwealth*

6:00-8:00 pm

Welcome Reception

*Constitution Foyer*

7:00-10:00 pm

AdCom Dinner

*Back Bay B*

### ***Monday, July 9***

7:30-8:00 am

Morning Devotions

*Exeter*

Noon-1:00 pm

Joint IEEE Antenna & Waves Standards Committees

*Beacon D*

Noon-1:00 pm

Transactions Editors Luncheon

*Exeter*

4:30-6:00 pm

Student Contest Poster Session

*Back Bay C*

5:30-6:30 pm

URSI B Business Meeting

*Hampton*

### ***Tuesday, July 10***

7:30-8:00 am

Morning Devotions

*Exeter*

Noon-1:00 pm

Magazine Staff Luncheon

*Exeter A*

Noon-1:00 pm

Antenna Measurements Committee. Luncheon

*Exeter B*

4:30-5:30 pm

Future Symposia Committee. Meeting

*Exeter*

5:30-6:30 pm

URSI Comm. A Bus. Meeting

*Hampton*

5:30-6:30 pm

URSI Comm. K Bus. Meeting

*Gardner*

6:00-8:00 pm

Women in Engineering Reception

*Commonwealth*

6:30-9:00 pm

Dinner Honoring R.W.P. King

*Fairfax A*

### ***Wednesday, July 11***

7:30-8:00 am

Morning Devotions

*Exeter*

Noon-1:00 pm

APS Transactions Reviewers Luncheon

*Constitution A*

6:00-7:00 pm

Pre-Banquet Cocktail Hour

*Constitution Foyer*

7:00-11:00 pm

Awards Banquet/Black Eagles Jazz Band

*Constitution*

### ***Thursday, July 12***

7:30-8:00 am

Morning Devotions

*Exeter*

Noon-1:00 pm

APS Press Liaison Committee Luncheon

*Exeter A*

Noon-1:00 pm

APS Chapter Chairs Luncheon

*Exeter B*

4:00-5:00 pm

2002 Symposium Committee

*Exeter*

### ***Friday, July 13***

Noon-1:00 pm

Lunch - Short Course Full Day Participants

*Back Bay C*

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## SHORT COURSES

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We are pleased to offer the following short courses. All courses will be held on Friday, July 13, 2001. For further information, please contact:  
Hans Steyskal, Air Force Research Laboratory  
hans.steyskal@hanscom.af.mil

### DETAILED DESCRIPTIONS OF COURSES

#### Full Day Courses

##### **SC-1: Genetic Algorithms in Engineering Electromagnetics: Concept, Implementation and Applications**

Prof. Yahya Rahmat-Samii, University of California, Los Angeles.  
Course fee: \$200 (Friday)

*Outline* : Since the early part of this decade, Evolutionary Optimization (EO) techniques have been applied with growing applications to the design of electromagnetic systems of increasing complexity. The recent popularity experienced by EO methods is not unique to the field of electromagnetics; in fact, EO techniques have been successfully applied to problems in fields ranging from engineering to economics and artificial intelligence. Among various EO's, Genetic Algorithms (GA) have attracted much attention. GA schemes are finding popularity in electromagnetics as design tools and problem solvers because of their versatility and ability to optimize in complex multimodal search spaces applied to non-differentiable cost functions.

##### **SC-2: Frequency Selective Surfaces - Theory and Design**

Prof. Ben A. Munk, The Ohio State University  
Course fee: \$300 (includes text book) (Friday)

*Outline*: The two most important applications of Periodic Surfaces are probably Frequency Selective Surfaces (FSS) and Phased Arrays. Important examples of the first category are band pass and band stop radomes designed to reduce out-of-band radar cross section (RCS) of antennas. Further uses are dichroic surfaces shaped as subreflectors, circuit analog absorbers, and meanderline polarizers. Design approaches leading to transmission curves with flat-top, steep roll-off and almost constant bandwidth with angle of incidence and polarization will be given. Also considered are band stop filters and dichroic surfaces as well as Circuit Analog Absorbers.  
Course fee includes the text book *Frequency Selective Surfaces, Theory and Design* by Ben A. Munk, John Wiley, NY 2000.

##### **SC-3: Practical Consideration in the Design of Antennas for Wireless Communication**

Dr. Tuli Herscovici, Spike Technologies. Course fee: \$200 (Friday)  
*Outline*: This short course will address specific topics related to the design and fabrication of antennas for wireless communication. In the first part, we will discuss the types of antennas used in this industry, as well as strategies for choosing the right antenna for a system. A short historical background will follow the evolution of the antenna industry from the military technology to the emerging commercial applications of

the late 90s. The second part will focus on antennas used in the wireless communication industry: microstrip antennas and arrays, wire antennas and MMwave antennas. In the third part of the course we will design different types of antennas using an electromagnetic simulator and compare the results with those obtained using different software packages.

#### **SC-4: Wireless Propagation and Smart Antennas**

Professor R. Janaswamy, Naval Postgraduate School, Monterey, CA.  
Course fee: \$300 (includes text book) (Friday)

*Outline:* In this full-day course we will discuss the principles and practical issues of radiowave propagation and smart antennas with application to wireless communications. Topics will include basics of cellular communications; path loss models; narrowband and wideband characterization of small scale signal fading—coherence bandwidth, coherence time, Doppler spread, angular spread and spatial correlation; diversity reception—spatial and polarization diversity, maximal-ratio/equal-gain/selection combining techniques; switched beam and sector beam antennas; adaptive antennas—beamforming, beamforming algorithms, capacity improvement, fading analysis, effect of element mutual coupling, implementation issues, etc; MIMO antennas and capacity improvement.

Course fee includes the text book *Radiowave Propagation and Smart Antennas for Wireless Communications* by R. Janaswamy, Kluwer Academic Publishers, November 2000.

#### **SC-5: EMI/EMC Computational Modeling for Real-World Engineering Problems**

Dr. Omar M. Ramahi, University of Maryland  
Dr. Bruce Archambeault, IBM, RTP, NC 27709

Course fee: \$200 (Friday)

*Outline:* The world of EMI/EMC compliance has become more important than ever before due to several technological advances such as high-speed processors and low cost packaging. The 'old ways' of using design rules and then fixing the EMI problems after the product is built, are not acceptable in today's highly competitive development environment. Designs must be cost effective, and must pass regulatory requirements the first time through the design cycle. Several detailed examples will be presented showing how to create real-world models. Radiated emissions, radiated susceptibility and ESD are all discussed and demonstrated with *real-world* problems. We conclude this course with a discussion of model validation techniques and present standard modeling problems that allow engineers to evaluate commercial software packages.

#### **SC-6: Engineering Applications of the Fast-MoM and Green's-Function-Based Wavelets**

Dr. Ali R. Baghai-Wadji, Vienna University of Technology, AUSTRIA.  
Course fee: \$200 (Friday)

*Outline:* To support the engineering and fabrication efforts in size reduction and power handling of RF- and microwave devices, there is a growing need in fast, accurate and robust modeling and simulation tools. In order to account for second- and higher-order parasitic effects in miniaturized devices, and thus to reliably predict device characteristics, rigorous 2D and 3D analysis methods seem inevitable. Modeling the cross-talk and EM fields in electronic packages, L and C calculations in

high density interconnects, the calculation of radiation impedance of antennas and ohmic losses, and the heat management modeling, are examples, which involve higher order effects that concern many electrical engineers and designers. This educational tutorial is devoted to the challenging task of modeling many of these problems.

## **1/2 Day Courses**

### **SC-7: Fractal Antennas**

Prof. Douglas Werner, The Pennsylvania State University.

Course fee: \$120 (Friday AM)

*Outline:* Fractal electrodynamics is a relatively new and rapidly growing field of research that deals with combining attributes of fractal geometry with Maxwell's theory of electromagnetism. One of the newest areas of fractal electrodynamics research concerns its application to antenna engineering, which promises to yield a rich class of new designs for multiband antenna elements as well as arrays (D.H. Werner and R. Mittra, *Frontiers in Electromagnetics*, IEEE Press, 2000). This short course will present an overview of research in the area of fractal antennas. Recent advancements in the fundamental theory and associated design methodologies for fractal antennas will also be discussed.

### **SC-8: Smart Antennas and Space-Time Adaptive**

#### **Processing (STAP)**

Prof. Tapan K. Sarkar, Syracuse University Course fee: \$120 (Friday AM)

*Outline:* In the conventional adaptive beamforming methodology typically the adaptive weights are connected to each one of the antenna elements in the array and the processing information is generated over time, as the correlation matrix of the data needs to be formed. Some of the problems associated with this procedure are that because of the formation of the covariance matrix of the received voltages and evaluation of its inverse, it is difficult to carry out the computations in real time. In addition, it is difficult to handle coherent multipaths in this methodology unless some additional processing is carried out. This course will present a novel methodology utilizing the direct data domain approach based on the spatial samples for the efficient computation of the adaptive weights in a phased array system. Finally, it will be shown as how to extend this methodology to two-dimensions, namely space-time adaptive processing (STAP).

### **SC-9: RF MEMS for Antenna Applications**

Dr. James R. Reid, Capt. USAF, AF Research Lab/SNHA

Course fee: \$120 (Friday AM)

*Outline:* Over the past several years, microelectromechanical systems (MEMS) have been attracting much attention in the microwave and millimeterwave research communities. This excitement has largely been driven by demonstrations of microwave switches with low insertion loss ( $<0.25$  dB @ 10 GHz), high isolation ( $>20$  dB @ 10 GHz), and low drive power. Further, these switches have recently been used to demonstrate phase shifters with exceptionally low microwave insertion loss. However, MEMS also has a broader impact. Research is ongoing in areas such as high performance, passive microwave components and micromachined waveguides and antennas. This half day short course



will provide a broad overview of MEMS for antenna applications with a particular emphasis on the design of micromechanical switches. The course will begin with a brief overview of the primary fabrication techniques including a description of the primary challenges and limitations of MEMS fabrication processes. This will be followed by a discussion of micromechanical actuators and their application to microwave and millimeterwave switches, followed by a detailed discussion of the design of electrostatically actuated RF switches including the trade-offs between electro-mechanical and microwave performance. Finally, the course will be concluded with a discussion of the implications of MEMS to antenna designers.

#### **SC-10: Photonics for Phased Array Systems**

Dr. Charles Cox, Dr. Ed Ackerman, Photonic Systems, Burlington, Mass. Course fee: \$120 (Friday AM)

*Outline:* This course will focus on two areas where photonics can be applied to phased array antennas: photonic microwave links for antenna remoting and optical methods for generating time delay. For the links section, we will present the small signal models for direct and external intensity-modulation analog links. We then discuss three of the most common measures of performance for analog links: gain, noise figure and intermodulation-free dynamic range, IMFDR. The limits of noise figure with passive matching and IMFDR under linearization are also presented. For the time delay section, we will discuss the various photonic methods that have been proposed and the strengths and limitations of each approach, such as the range of time delays they can generate, their ability to do 2 dimensional arrays, to do multiple simultaneous beams, etc.

#### **SC-11: Radar Reflectivity of Land and Sea: 1975 to 2000**

Dr. Maurice W. Long, Private Consultant Course fee: \$220 (includes text book) (Friday AM)

*Outline:* This tutorial is based on a recent literature review and editing for completing Radar Reflectivity of Land and Sea, 3rd edition, Artech House, scheduled for release in April 2001. Major findings on surface reflectivity, reported since 1975 when the first edition was published, will be highlighted. The course objective is to identify the current knowledge of land and sea reflectivity in a manner which is understandable to both new and experienced radar engineers. The tutorial will begin with a historical survey of earth surface observations, which will be followed by a discussion of basic reflectivity concepts and definitions. Course material will include echo amplitude statistics, coherent and noncoherent Doppler spectra, super sea echo events, sea spikes, compound distributions for describing space-time amplitude statistics, and models and tables of radar cross section for land and sea. Emphasis will be on radar backscatter, but an introductory discussion will be included on bistatic land and sea clutter. The tutorial will be closed with a summary of new findings on monostatic and bistatic scattering from land and sea.

Course fee includes the text book *Radar Reflectivity of Land and Sea*, 3<sup>rd</sup> ed., by Maurice Long, Artech House, March 2001

#### **SC-12: Microstrip Antennas**

Dr. Rod Waterhouse, Royal Melbourne Institute of Technology, Australia. Course fee: \$120 (Friday AM)

*Outline:* Microstrip or printed antennas are being considered/used in a variety of communication systems due to their many advantages, including low profile, light weight and ease of integration with microwave and photonic devices. In this course we will cover a number of topics that are fundamental to developing an understanding of microstrip patch antennas and the role that they play in developing wireless communication systems. These include: (1) the general characteristics of microstrip patches; (2) a comparison of the excitation/feeding methods; (3) techniques to improve the impedance bandwidth; (4) methods to generate circular polarization; (5) methods to reduce the size of the patch conductor; (6) how to efficiently integrate these antennas with MMIC and OEIC technologies; (7) a comparison of array architectures; and (8) methods to design omni-directional printed antennas. For all these topics, practical design cases will be given. Finally, if time permits, simple design procedures for several printed antenna configurations will be presented.